GEA-439B*

Brooklyn Edison Building Illuminated by Floodlighting Projectors

A Short Cut to the Solution of Floodlighting Problems

*Supersedes GEA-439A

A Short Cut to the Solution of Floodlighting Problems

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The inception of floodlighting dates back to the year 1915, when the Panama-Pacific Exposition made the first notable use of it. The method of lighting exteriors in vogue up to that time consisted mainly in hanging strings of incandescent or arc lamps across the front of the building to be lighted, or on neighboring poles, trees, etc., which was an arrangement unsightly in appearance as well as in the production of a general glare which detracted from, rather than added to, the natural beauty of the structure.

Floodlighting, however, met these objections by concealing the sources of light and bringing the facade of the building into brilliant relief against the darkness, accentuating the details of construction and adding a new beauty to them. Architects and engineers promptly approved this innovation in the art of illumination because it gave the building a real rather than an artificial appearance at night, and also did not detract from its looks in the daytime. With the impetus given to it by the Panama-Pacific Exposition, floodlighting at once became a special department of illumination practice, and the years that have passed since then have seen constant improvements in equipment, as well as a rapidly widening field for its application. T-day, floodlighting is looked upon as one of the important uses of the electric light.

This method of illumination is recognized as a successful form of advertising and a stimulus to business. The rapidly increasing number of such installations throughout the world proves that it has become a necessity, and indicates that a still more advantageous and extensive use of it awaits only an increased familiarity with methods for the solution of such problems and the selection of suitable equipment.

Although the field of this type of lighting has been greatly extended during the past few years, the future is still more promising. Among the many prominent applications coming into favor to-day, are those for scenic displays, aviation landing fields, evening football and baseball games, electric fountain illumination, building and construction at night, freight yards, grain elevators, quarries, shipyards, docks, billboards, signs, advertising banners, etc. Typical examples such as are given in Fig. 1, 2, 3, and 4 illustrate how well floodlighting units can be used for a wide variety of purposes.

Installation Factors

The directional distribution of a floodlight causes sharp shadows that make it unsuitable for general interior illumination. Commercial floodlights with clear doors have an approximate spread of 11 to 50 deg., so that the type to be used will depend upon local conditions.

There are three important factors to be considered before it can be definitely determined what type of unit will best meet the conditions encountered:

(1) The working distance; i.e., the distance from the projectors to the surface to be illuminated.

(2) The surrounding characteristics; i.e., whether the area to be lighted is located along a "white way," a residential section, a park, or a place where there is no other light source.

(3) The color of the object to be illuminated; i.e., whether the surface is dark, medium, or light.

The first of these determines the most suitable type of projector. The second and third determine the foot-candle intensity required. When selecting floodlighting projectors, particular consideration must be given to the area that is to be illuminated, to the beam spread, and to the distance the beam is to be projected. Naturally the use of a wide-beam

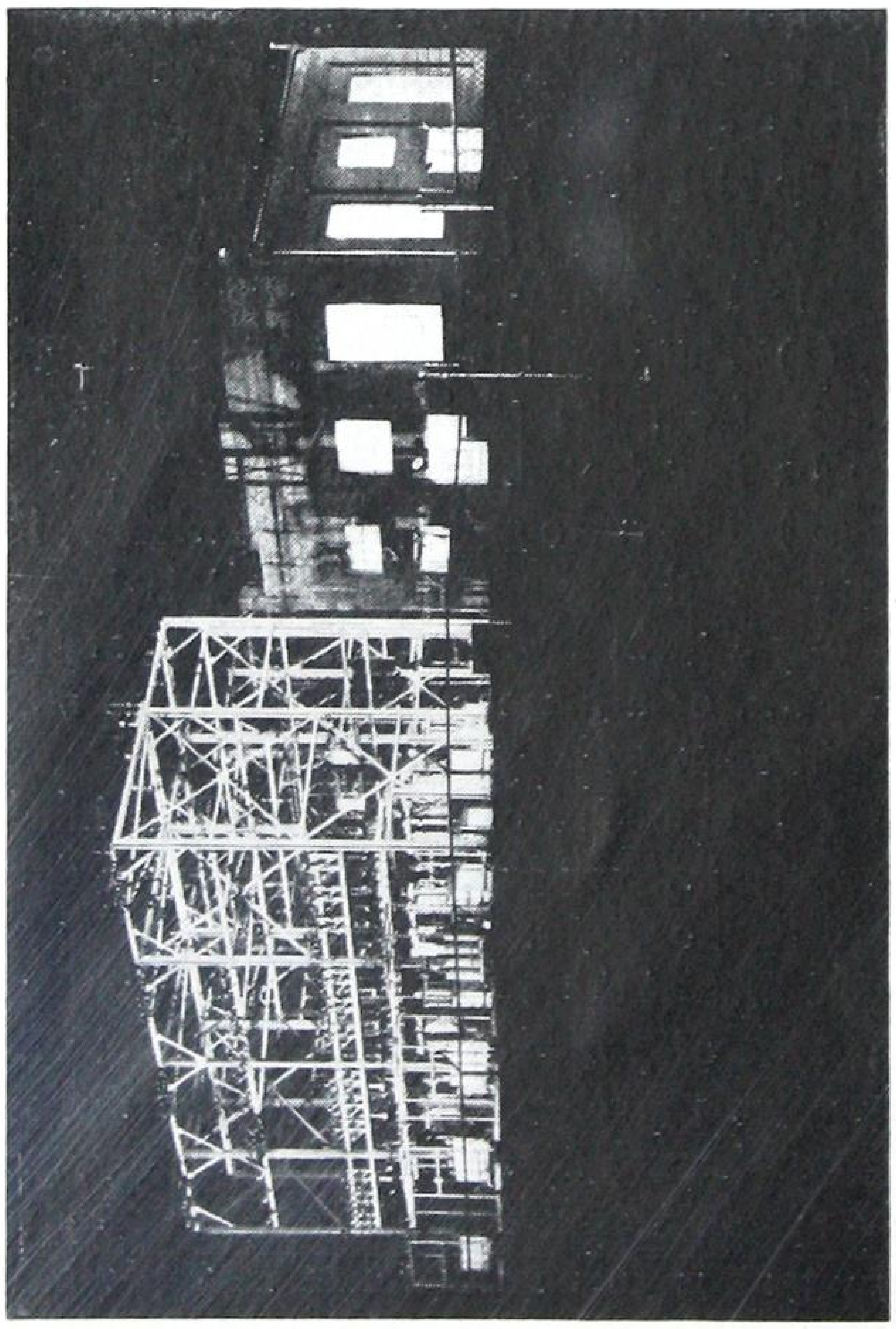


Fig. 1. Outdoor Electric Switching Yard by Night

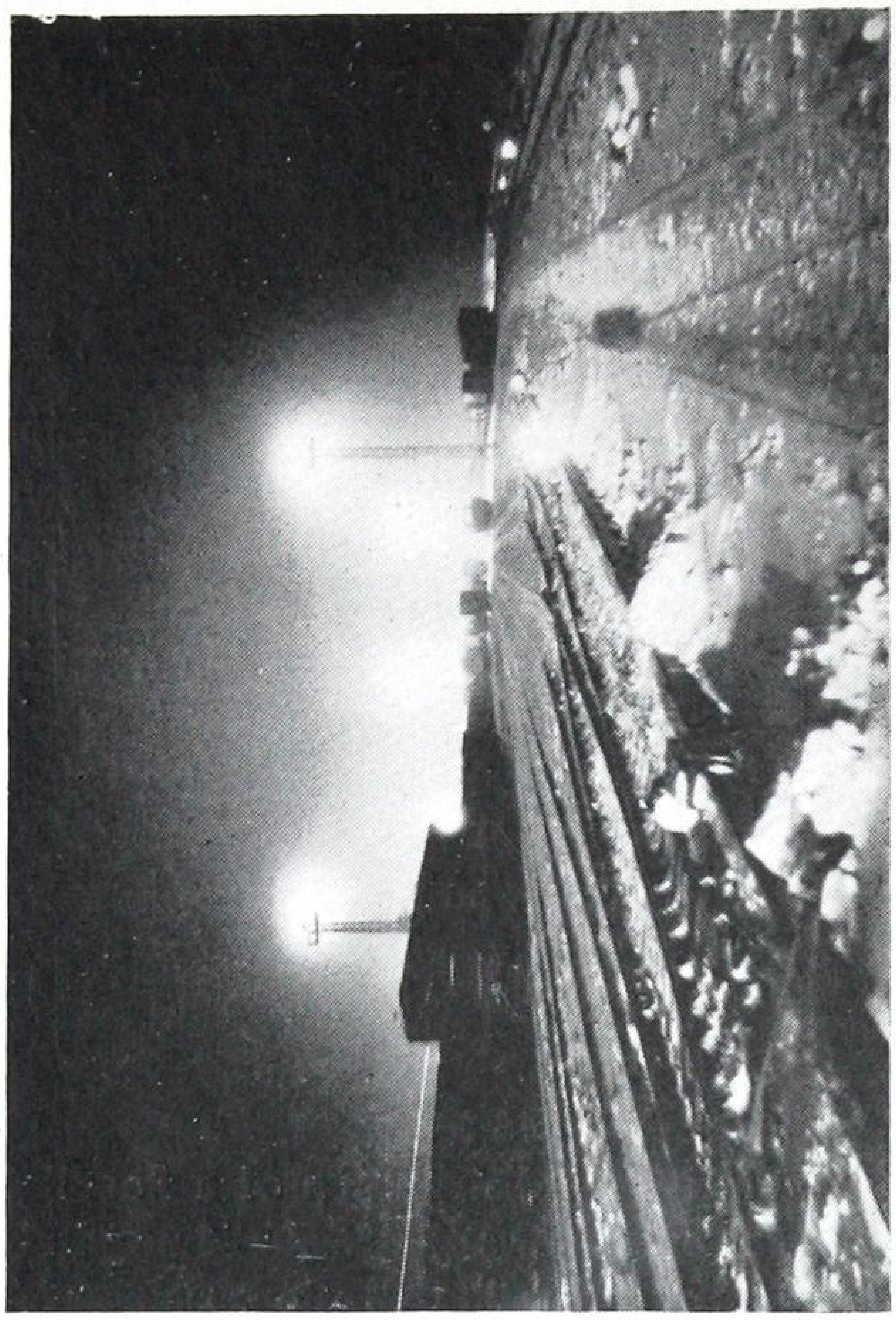


Fig. 2. Railroad Freight Yard with Floodlighting

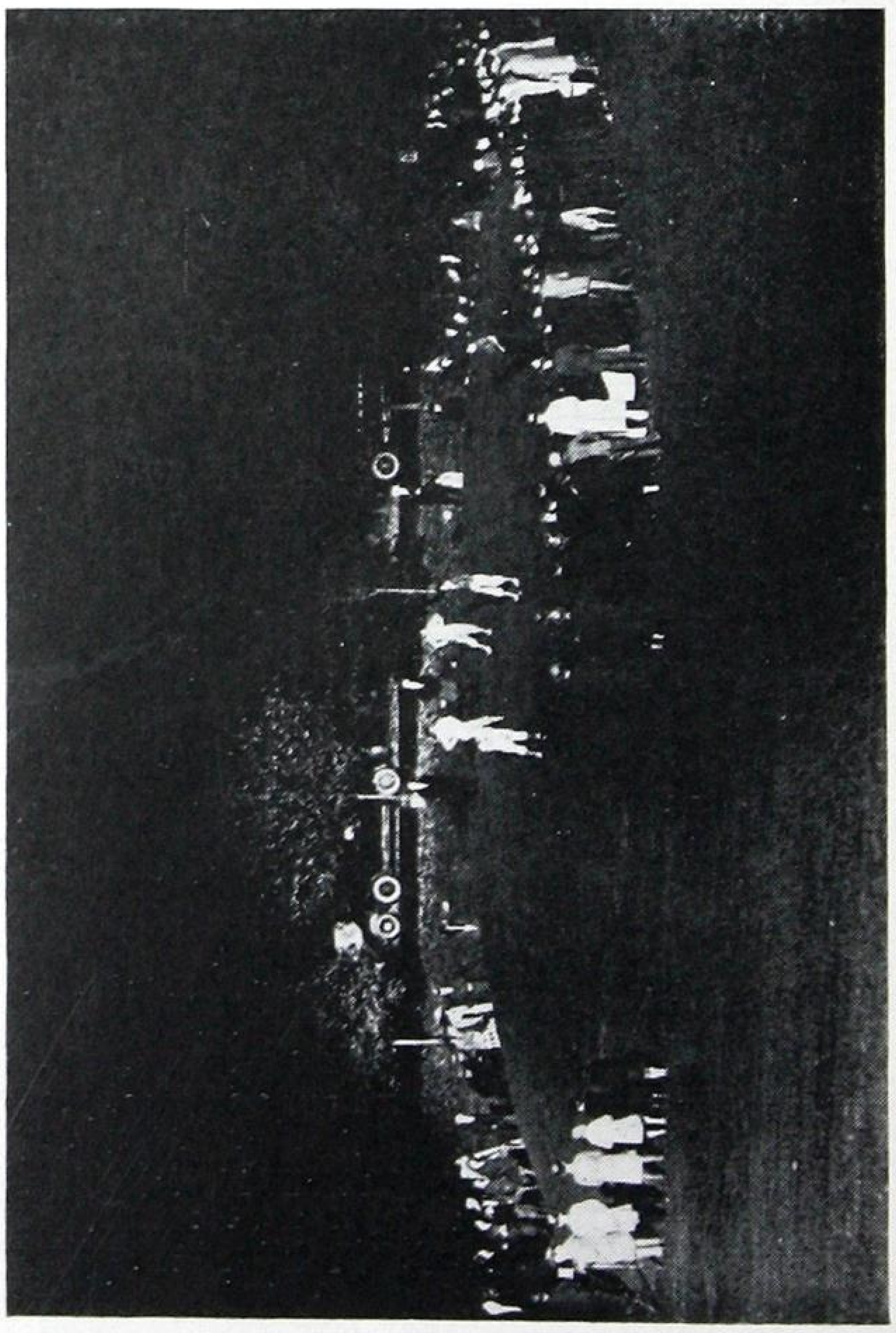


Fig. 3. Playing Golf After Dark

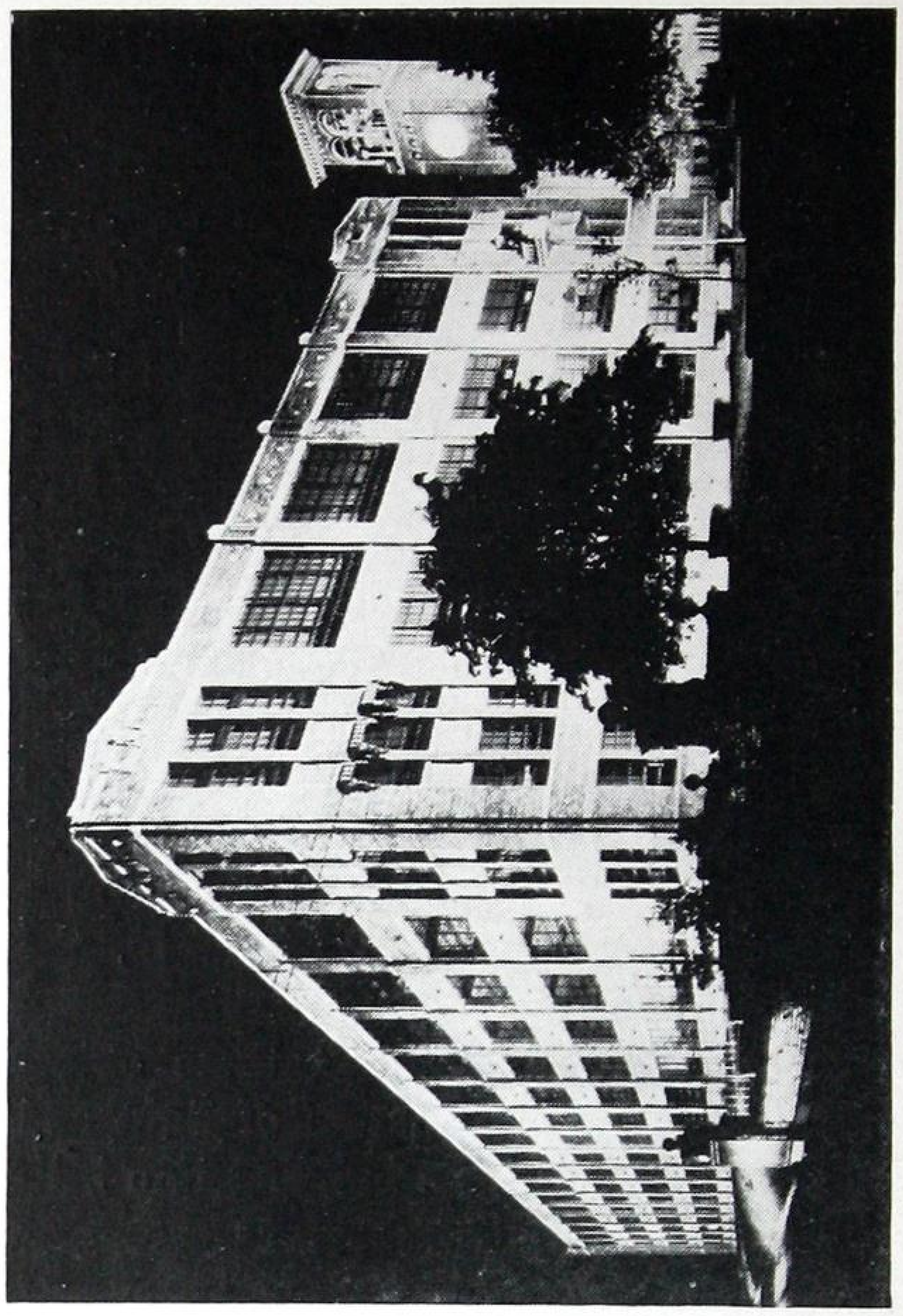


Fig. 4. Industrial Building with Facade Completely Illuminated

unit for a small area or a narrow-beam unit for a large area will not give satisfactory results.

For the many cases where the angle between the beam axis and the surface to be illuminated lies between 70 and 90 deg., the data given in Table I will determine the most suitable type of floodlight and the number of units necessary.

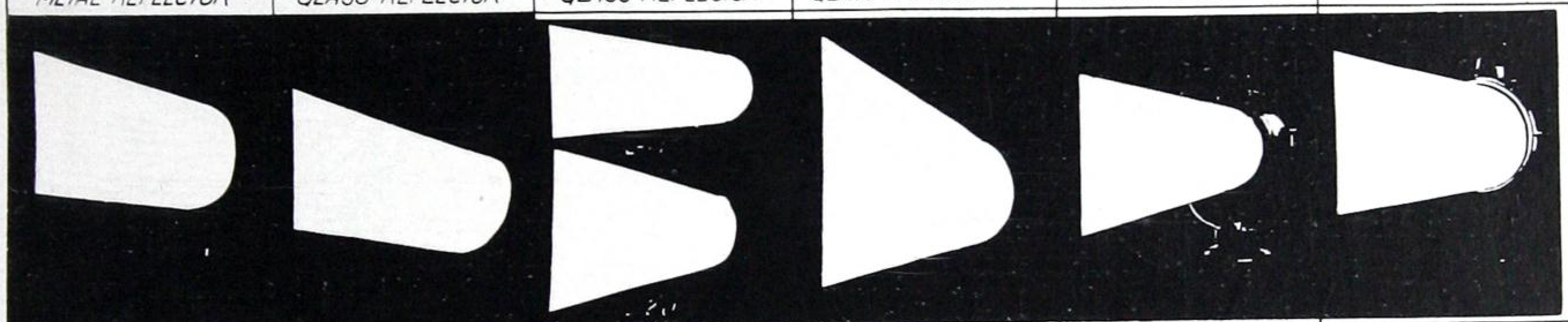
When computing intensity values, note may be made of the fact that full moonlight is approximately 1/40 foot-candle. Table I gives the following data: the type of floodlight units, the size of lamps used in each type of unit, the photograph of the unit, the beam spread, the working distance for each type of projector, and curves indicating the number of units required to illuminate areas at various intensities. Table II lists the intensities that should be used for white-ways, residential sections, and parks when the surfaces are dark, medium, or light.

Examples

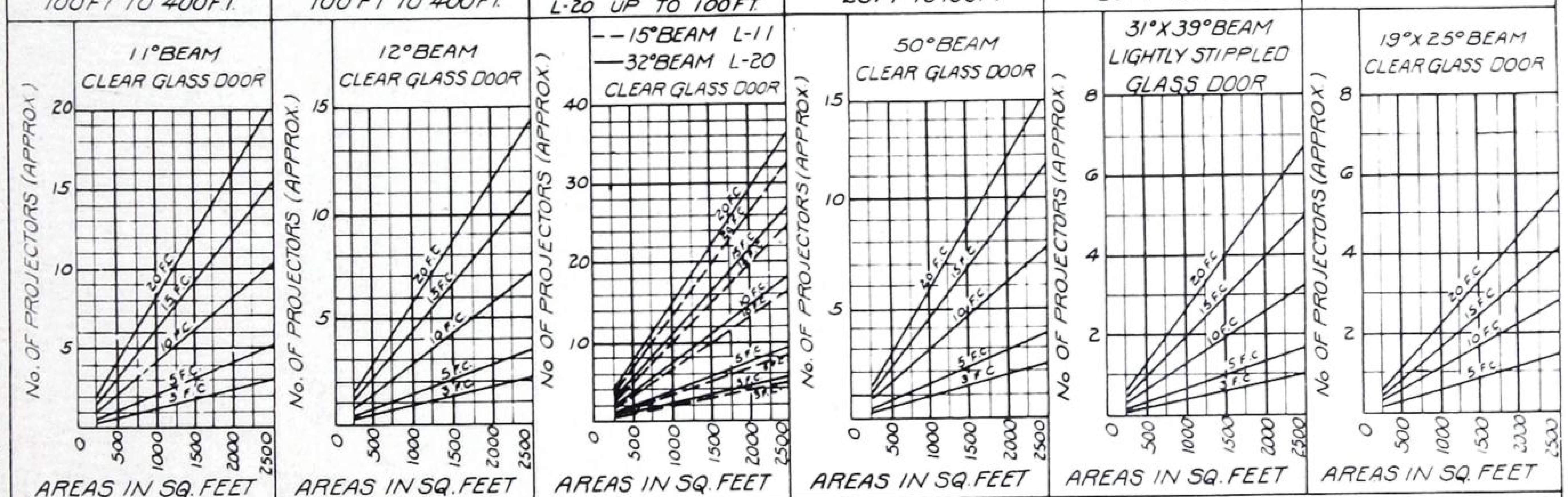
To furnish an example of the application of the data given in Table I, a problem involving the lighting of an area 1500 sq. ft. will be computed. The conditions require the units to be installed 130 ft. from the surface to be illuminated. The color of the building

TABLE I

FORM L-1 500W FLOODLIGHTING LAMP METAL REFLECTOR	FORM L-9 500W FLOODLIGHTING LAMP GLASS REFLECTOR	FORM L-20 AND L-11 200W-250W F'LD.LTG LAMP GLASS REFLECTOR	** FORM L-3 500W FLOODLIGHTING LAMP GLASS REFLECTOR	FORM L-15 1000W ST'D MAZDA LAMP GLASS REFLECTOR	FORM L-22 AND L-24 1000W STD MAZDA LAMP GLASS REFLECTOR



WORKING DISTANCE 100 FT TO 400 FT.	WORKING DISTANCE 100 FT TO 400 FT.	WORKING DISTANCE L-11 UP TO 200 FT. L-20 UP TO 100 FT.	WORKING DISTANCE 25 FT TO 100 FT	WORKING DISTANCE 50 FT TO 175 FT	WORKING DISTANCE 75 FT TO 500 FT



CLEAR GLASS DOOR

DISTANCE FROM PROJECTOR IN FEET	L-1 DIA. FT	L-1 AREA SQ.FT	L-1 AVE. F.C.	L-9 DIA. FT	L-9 AREA SQ.FT	L-9 AVE. F.C.	DIA. FT L-11	DIA. FT L-20	AREA SQ.FT L-11	AREA SQ.FT L-20	AVE. F.C L-11	AVE. F.C L-20	L-3 DIA. FT	L-3 AREA SQ.FT	L-3 AVE. F.C.	L-15 DIA FT	L-15 AREA SQ.FT	L-15 AVE. F.C	L-22/L-24 DIA FT	L-22/L-24 AREA SQ.FT	L-22/L-24 AVE F.C.
25	4.8	18	135	5.2	22	155	7	14	34	163	44	8.3	23	426	7.7	14X18	194	38.2	8.4X11	73	123
50	9.6	73	33.2	11	86	39.6	13	29	136	650	11	2.1	47	1707	1.9	28X35	775	9.5	17X22	291	30.8
75	14	164	14.8	16	194	17.5	20	43	307	1462	4.9	0.93	70	3840	0.85	42X53	1741	4.2	25X33	655	13.7
100	19	292	8.3	21	346	9.8	26	58	544	2600	2.8	0.52	93	6820	0.48	56X71	3100	2.4	33X44	1164	7.7
125	24	455	5.3	26	542	6.3	33	72	850	4065	1.8	0.33				70X88	4840	1.5	42X55	1820	4.9
150	29	656	3.7	31	780	4.4	40		1225		1.2					84X106	6970	1.1	50X66	2620	3.4
175	34	892	2.7	37	1060	3.2	46		1667		0.90					98X124	7490	0.99	59X78	3565	2.5
200	39	1164	2.1	42	1385	2.5	53		2180		0.69					111X142	12400	0.60	67X89	4660	1.9
250	48	1820	1.3	52	2165	1.6	66		3400		0.44					140X177	19360	0.38	84X111	7280	1.2
300	58	2620	0.93	63	3117	1.1	79		4900		0.31								100X133	10480	0.86
350	67	3565	0.68	74	4242	0.80													117X155	14270	0.63
400	77	4660	0.52	84	5540	0.62													134X177	18620	0.48
450	87	5900	0.41	95	7010	0.49													151X199	23580	0.38
500	96	7280	0.33	105	8660	0.39	L-11	L-20	L-11	L-20	L-11	L-20							167X222	29100	0.31

STIPPLED GLASS DOOR

DISTANCE FROM PROJECTOR IN FEET	L-1 DIA. FT.	L-1 AREA SQ.FT	L-1 AVE.F.C.	L-9 DIA. FT	L-9 AREA SQ.FT.	L-9 AVE.F.C.	DIA FT. L-11	DIA FT. L-20	AREA SQ.FT L-11	AREA SQ.FT L-20	AVE. F.C L-11	AVE. F.C L-20	L-3 DIA. FT	L-3 AREA SQ.FT.	L-3 AVE.F.C	L-15 DIA FT	L-15 AREA SQ.FT	L-15 AVE.F.C.	L-22/L-24 DIA FT.	L-22/L-24 AREA SQ.FT	L-22/L-24 AVE F.C
20	18	249	11.2	19	273	14.1	12	17	117	226	13.8	6.3	40	1256	3.4				9.2X11	81	108
30	27	560	5	28	615	6.2	18	25	264	509	6.1	2.8	60	2827	1.5				14X17	183	47.7
40	36	994	2.8	37	1091	3.5	24	34	469	905	3.4	1.8	80	5026	0.86				18X22	323	27
50	45	1555	1.8	47	1708	2.2	31	42	730	1413	2.2	1.0							23X28	505	17.2
60	53	2240	1.3	56	2463	1.6	37	51	1054	2038	1.5	0.70							28X33	726	12
70	62	3045	0.92	65	3343	1.1													32X39	989	8.8
80	71	3980	0.70	75	4370	0.88													37X44	1290	6.8
90	80	5040	0.56	84	5530	0.69													42X50	1633	5.3
100	89	6220	0.45	93	6829	0.56	L-11	L-20	L-11	L-20	L-11	L-20							46X56	2015	4.3

** The manufacture of L-3 projectors has been discontinued.

NOTE.—In using Table I the angle between axis of beam and surface lighted must not be less than 70 degrees.

One-way Projection of Light

Advantages:
- Economical to install and maintain
- No glare

Disadvantages:
- No silhouette effect
- Non-uniform distribution of light
- Inefficient in smoke or fog

Distributed System

Light Projected in the Direction of Traffic

Advantages:
- Uniform distribution of light
- Effective in smoke or fog
- No glare

Disadvantages:
- Higher installation and maintenance cost

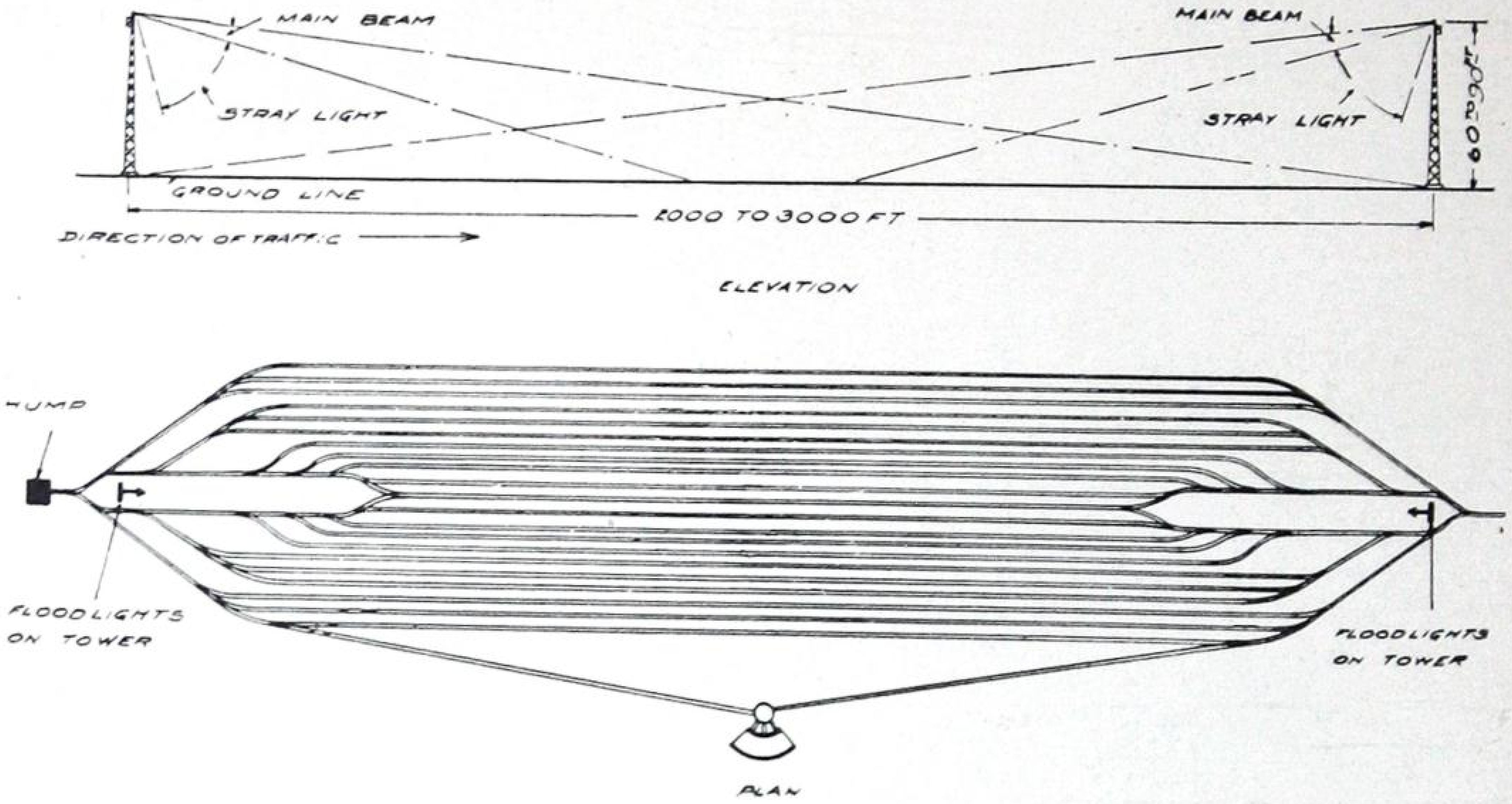


Fig. 8. Schematic Diagram of the Selkirk Switching Yards of the New York Central Railroad Showing Method of Floodlight Distribution

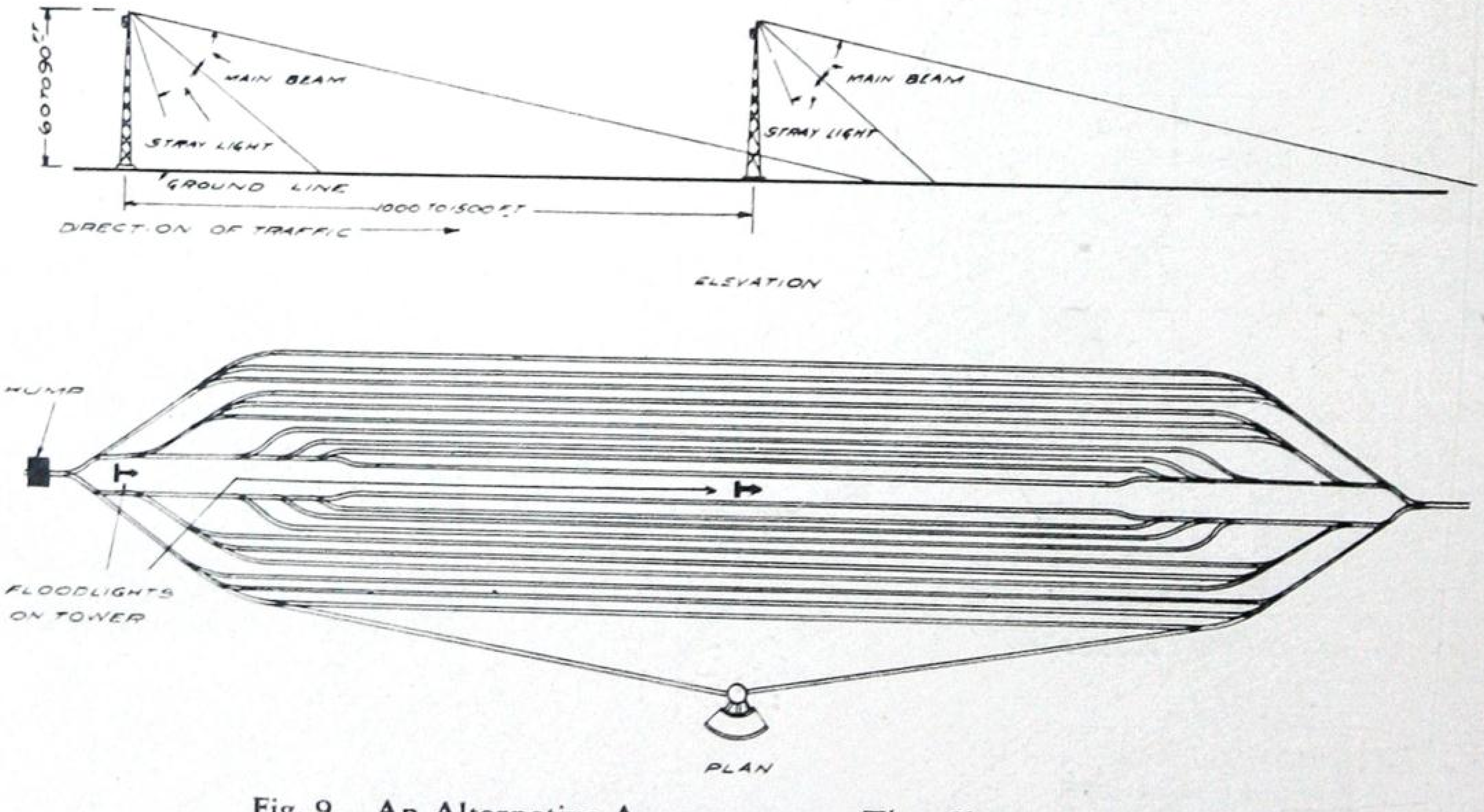


Fig. 9. An Alternative Arrangement to That Shown in Fig. 8

Fig. 10. Low Power Floodlighting with Close Spacing to Avoid Glare

Light Projected Against Direction of Traffic

Advantages:
- Uniform distribution of light
- Effective in smoke or fog
- Silhouette effect

Disadvantages:
- Higher installation and maintenance cost
- Possible glare.

Another variation of the distributed system is that in which the light is projected diagonally across the tracks against the direction of traffic. The projectors, singly, or in pairs, are as a rule mounted on 75-ft. poles or towers, spaced from 200 to 500 ft. apart. This system gives the silhouette effect and the effect of specular reflection from the rails, and also tends to provide uniform illumination throughout the yard.

Whatever system be used, the proper mounting height for the projectors is a most important matter. The greater mounting heights are preferable in order to minimize as much as possible the dangerous glare effects, to give a more uniform distribution of light, and to eliminate objectionable shadows. Towers 75 ft. high above the rails should be considered the minimum projector mounting height. Towers as high as 120 ft. are in use, and many of 90 ft. or more have been installed.

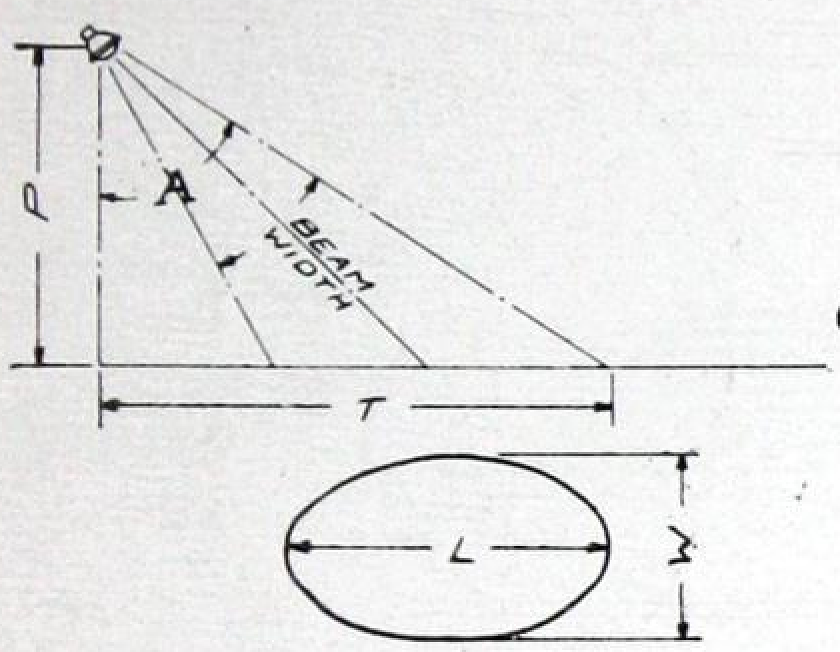
The projection efficiency of the unit is another important consideration. The suitability of the unit in this respect is measured

TABLE V

ILLUMINATING EFFICIENCY OF L-22 PROJECTOR

Approx. Watts. Per Sq. Ft.	Approx. Average Ft-cd.
0.0056	0.05
0.011	0 10
0 017	0.15
0 022	0 20
0.028	0 25

TABLE VI



FOOT-CANDLE INTENSITIES BASED ON ONE PROJECTOR ONLY USING A 1000 WAT MAZDA C MULTIPLE LAMP
PROJECTOR WITH CLEAR DOOR GIVES 8825 BEAM LUMENS, 24° BEAM
PROJECTOR WITH STIPPLED DOOR GIVES 8950 BEAM LUMENS 32° BEAM
(FIGURES ARE CLOSE APPROXIMATIONS ONLY)

CLEAR GLASS DOOR

HEIGHT P	70 FT					80 FT					90 FT					100 FT					120 FT				
DISTANCE T	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC
200	70°43'	126'	61'	6040	1.46	68°12'	122'	64'	6190	1.43	65°46'	120'	68'	6350	1.39	63°26'	118'	71'	6550	1.35	59°2'	116'	77'	7000	1.26
400	80°5'	296	94'	21800	0.41	78°41'	287'	99'	22280	0.40	77°19'	279'	103'	22665	0.39	75°58'	272'	108'	23000	0.38	73°18'	261'	115	23580	0.38
600	83°21'	482'	120'	45320	0.20	82°25'	470'	126'	46650	0.19	81°28'	459'	133'	47760	0.19	80°32'	449'	138'	48670	0.18	78°41'	431'	148'	50125	0.18
800	85°	674'	142'	74925	0.12	84°17'	660'	150'	77620	0.11	83°35'	647'	157'	79900	0.11	82°53'	634	164	81825	0.11	81°28'	612'	177'	84910	0.10
1000	86°	868'	161'	109640	0.08	85°26'	853'	170'	114120	0.08	84°51'	839'	179'	117978	0.08	84°17'	825'	187'	121270	0.07	83°9'	799'	202	126690	0.07
2000	88°	1857'	235'	342500	0.03	87°43'	1838'	250	360000	0.02	87°25'	1820'	264'	377500	0.02	87°8'	1803'	277'	391000	0.02	86°34'	1769'	304'	421000	0.02

LIGHT STIPPLED GLASS DOOR

100	55°	70'	53'	2935	3.05	51°20'	72'	57'	3250	2.76	48°1'	74	62	3605	2.48	45°0'	77	66	4000	2.24	39°48'	84	76	4970	1.80
200	70°43'	144'	76'	8575	1.04	68°12'	141'	81'	8960	1.00	65°46'	140	85	9300	0.96	63°26'	139	89	9750.	0.92	59°2'	139	98	10650	0.84
300	76°52'	230'	96'	17350	0.52	75°4'	225'	102'	17980	0.50	73°18'	221	107	18500	0.48	71°34'	217	112	19050	0.47	68°12'	212	121	20150	0.45
400	80°5'	322'	114'	28800	0.31	78°42'	315	120	29800	0.30	77°19'	309	126	30650	0.29	75°58'	304	132	31400	0.29	73°18'	295	142	33000	0.27
500	82°2'	417'	129'	42300	0.21	80°55'	408	137	43700	0.20	79°48'	401	144	45450	0.20	78°41'	393	150	46250	0.19	76°30'	382	162	48700	0.18
1000	86°	904'	191'	134850	0.07	85°26'	892	202	141800	0.06	84°51'	881	213	147650	0.06	84°17'	871	225	152800	0.06	83°9'	851	242	161700	0.06

surface is dark. What type of floodlighting unit should be used? What is the intensity and the number of units required?

In solving this problem the three controlling conditions are:

(1) The floodlights are to be located 130 feet from the illuminated surface.

(2) The object to be floodlighted is in a whiteway section.

(3) The surface to be illuminated has a dark finish.

Table I shows that all the projectors, except the L-3 and L-20 can be used up to a working distance of about 130 feet when equipped with clear-glass doors.

Table II shows that the intensity required for dark surfaces in white-way sections is 20 ft-cd. Assume that the L-15 projector in Table I is selected from which can be determined the number of units necessary to illuminate the area to an intensity of 20 ft-cd. Follow the vertical line from 2000 sq. ft. until it crosses the 20 ft-cd. curve; then by following the horizontal line to the left it will be found that four floodlights should be used. Care should be taken of course to provide sufficient overlapping of the beams to insure even illumination over the entire surface. This example will adequately illustrate all high-intensity floodlighting problems.

Table I also includes data of diameters, areas of the beams and foot-candle intensity of each unit with clear-glass and with stippled-glass doors. A typical problem making use of this information will be given. An area of about 1800 sq. ft. is to be illuminated. The units are to be installed 250 ft. from the illuminated area, there being no other source of light. The set of 250-ft. working distance readings in Table I is reproduced in Table III and shows that the L-1 beam will cover an area of 1820 sq. ft. with approximately fifty times the intensity of moonlight.

TABLE II

BUILDING SURFACES	CHARACTER OF SURROUNDINGS		
	WHITE WAY	RESIDENCES	PARKS
DARK COLORED BLDG. I.E. SURFACES OF RED BRICK, CLINKER BRICK, BROWN STONE ETC.	20 F.C.	15 F.C.	10 F.C.
MEDIUM COLORED BLDG. I.E. SURFACES OF CONCRETE, GRANITE ETC.	15 F.C.	10 F.C.	5 F.C.
LIGHT COLORED BLDG. I.E. SURFACES OF GLAZED TERRA COTTA, MARBLE ETC.	10 F.C.	5 F.C.	3 F.C.

It should be remembered that the average foot-candle intensities given in Table I indicate values produced by one unit alone. To increase these intensities, additional units must be used.

TABLE III

	FORM L-1	FORM L-9	FORM L-11	FORM L-15	FORM L-22
BEAM SPREAD, DEG.	11°	12°	15°	31°X39°	19°X25°
BEAM DIAMETER, FT.	48	52.0	66.0	140X177	84X111
BEAM AREA, SQ. FT.	1820	2165	3400	19360	7280
AVERAGE FOOT CANDLES	1.30	1.60	0.44	0.38	1.20

For the various floodlighting units, Table IV gives the lamp wattages, lamp lumens, total lumens, and beam lumens for both clear-glass and stippled-glass doors. It will be further observed that a formula is given at the bottom for determining the number of projectors.

TABLE IV

CLEAR GLASS DOOR

FORM	PHOTO CURVE	WATTS	LAMP BULB	SERVICE	REFLECTOR	LAMP LUMENS	TOTAL LUMENS	BEAM LUMENS	BEAM WIDTH
L-1	C-61137	500	G-40	FLOODLIGHTING	METAL	8150	5000	2420	11°
L-9	H-130841	500	G-40	FLOODLIGHTING	GLASS	8150	6100	3405	12°
L-11	C-61242	250	G-30	FLOODLIGHTING	GLASS	3500	2385	1500	15°
L-20	H-107613	200	PS-30	GENERAL	GLASS	3200	2075	1360	32°
L-3	C-61148	500	G-40	FLOODLIGHTING	GLASS	8150	4950	3270	50°
* L-15	H-132851	1000	PS-52	GENERAL	GLASS	21000	13300	7400	31°V X 39°H
L-22 & L-24	H-132789	1000	PS-52	GENERAL	GLASS	21000	14450	8960	19°V X 25°H

STIPPLED GLASS DOOR

FORM	PHOTO CURVE	WATTS	LAMP BULB	SERVICE	REFLECTOR	LAMP LUMENS	TOTAL LUMENS	BEAM LUMENS	BEAM WIDTH
L-1	C-61249	500	G-40	FLOODLIGHTING	METAL	8150	4890	2800	48°
L-9	H-130842	500	G-40	FLOODLIGHTING	GLASS	8150	5780	3840	50°
L-11	H-132853	250	G-30	FLOODLIGHTING	GLASS	3500	2330	1610	34°
L-20	H-132857	200	PS-30	GENERAL	GLASS	3200	2060	1420	46°
L-3	C-61149	500	G-40	FLOODLIGHTING	GLASS	8150	4680	4320	90°
L-15		1000	PS-52	GENERAL	GLASS	21000			
L-22 & L-24	H-132790	1000	PS-52	GENERAL	GLASS	21000	13650	8720	26°V X 31°H

* LIGHTLY STIPPLED GLASS DOOR

$$\text{NUMBER OF PROJECTORS} = \frac{\text{AREA OF BLDG. FACADE X F.C. REQUIRED}}{\text{BEAM LUMENS OF ONE PROJECTOR}}$$

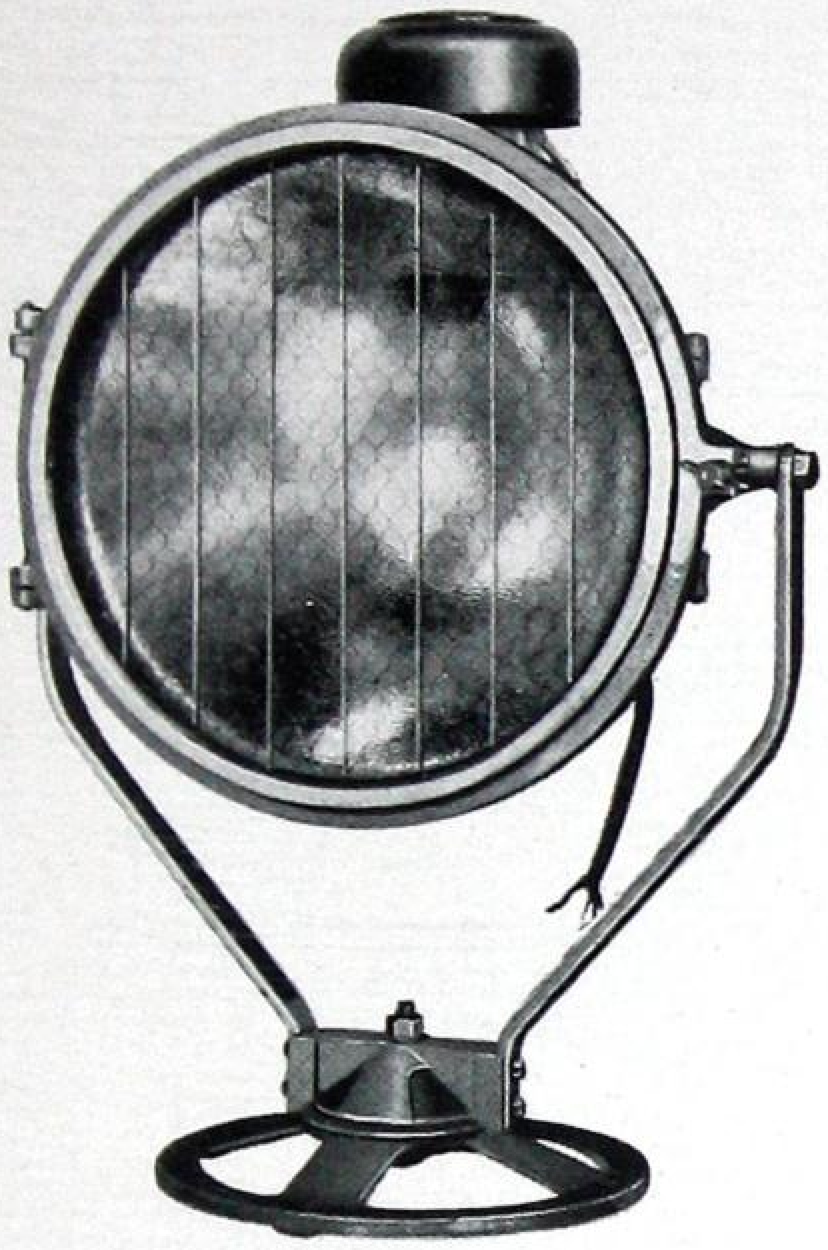
Lighting Railroad Yards

A few remarks applying to railroad yard lighting by L-22 floodlighting projectors, which are designed for this class of service, may be of interest. Fig. 5 and 6 show two views of this unit. Fig. 7 shows a group of these units mounted on a 75-ft. tower. The lamp usually employed is of the 1000-watt "base up" burning type. The following

are some of the advantages of floodlighting railroad yards:

(1) Increased speed of handling cars at night.

(2) Fewer cars damaged by rough handling and by collision, resulting in a reduction of damage claims, fewer delays in delivery of goods, and decreased loss of car service.



Front View

Rear View

Fig. 5 and 6. Two Views of Form L-22 Floodlight Projector.

(3) Lower losses due to pilfering, owing to a well-lighted yard which enables more effective policing.

(4) Improved and safer working conditions for yard employees.

It is generally conceded that floodlighting is the most economical and effective method of lighting such areas. Several variations in the installation layout for floodlighting projectors in this service may be observed by referring to the sketches in Fig. 8, 9, and 10.

The units may be installed on towers 70 to 90 ft. high, Fig. 7 showing the group method of arrangement with one-way projection of light.

The following are believed to be some of the advantages derived from the various methods employed, for the different classes of railroad yards.

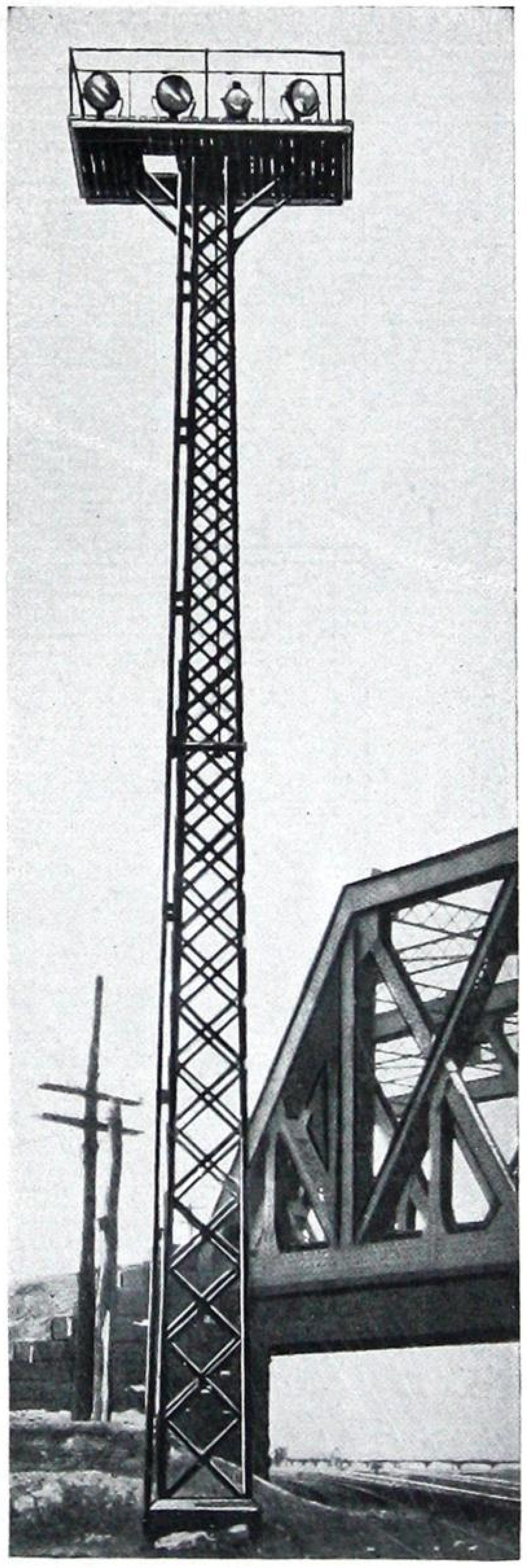


Fig. 7. Group of Floodlight Projectors for Railroad Yard Service Mounted on 75-foot Tower

Group System

Two-way Projection of Light

Advantages:
- Economical to install and maintain
- Silhouette effect

Disadvantages:
- Non-uniform distribution of light
- Inefficient in smoke or fog
- Danger from glare.

One-way Projection of Light

- Advantages:
  - Economical to install and maintain
  - No glare
- Disadvantages:
  - No silhouette effect
  - Non-uniform distribution of light
  - Inefficient in smoke or fog

Distributed System

Light Projected in the Direction of Traffic

- Advantages:
  - Uniform distribution of light
  - Effective in smoke or fog
  - No glare
- Disadvantages:
  - Higher installation and maintenance cost

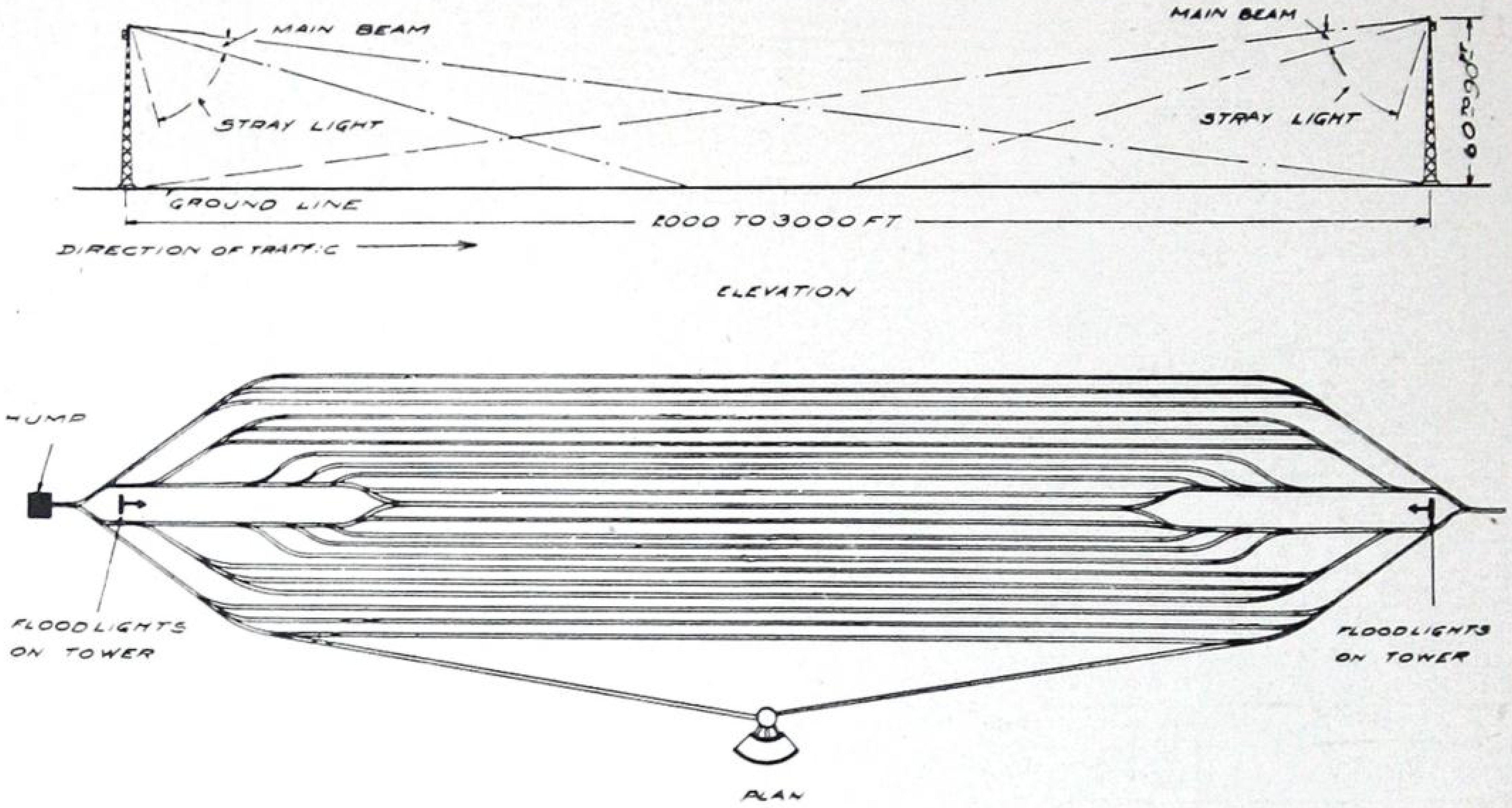


Fig. 8. Schematic Diagram of the Selkirk Switching Yards of the New York Central Railroad Showing Method of Floodlight Distribution

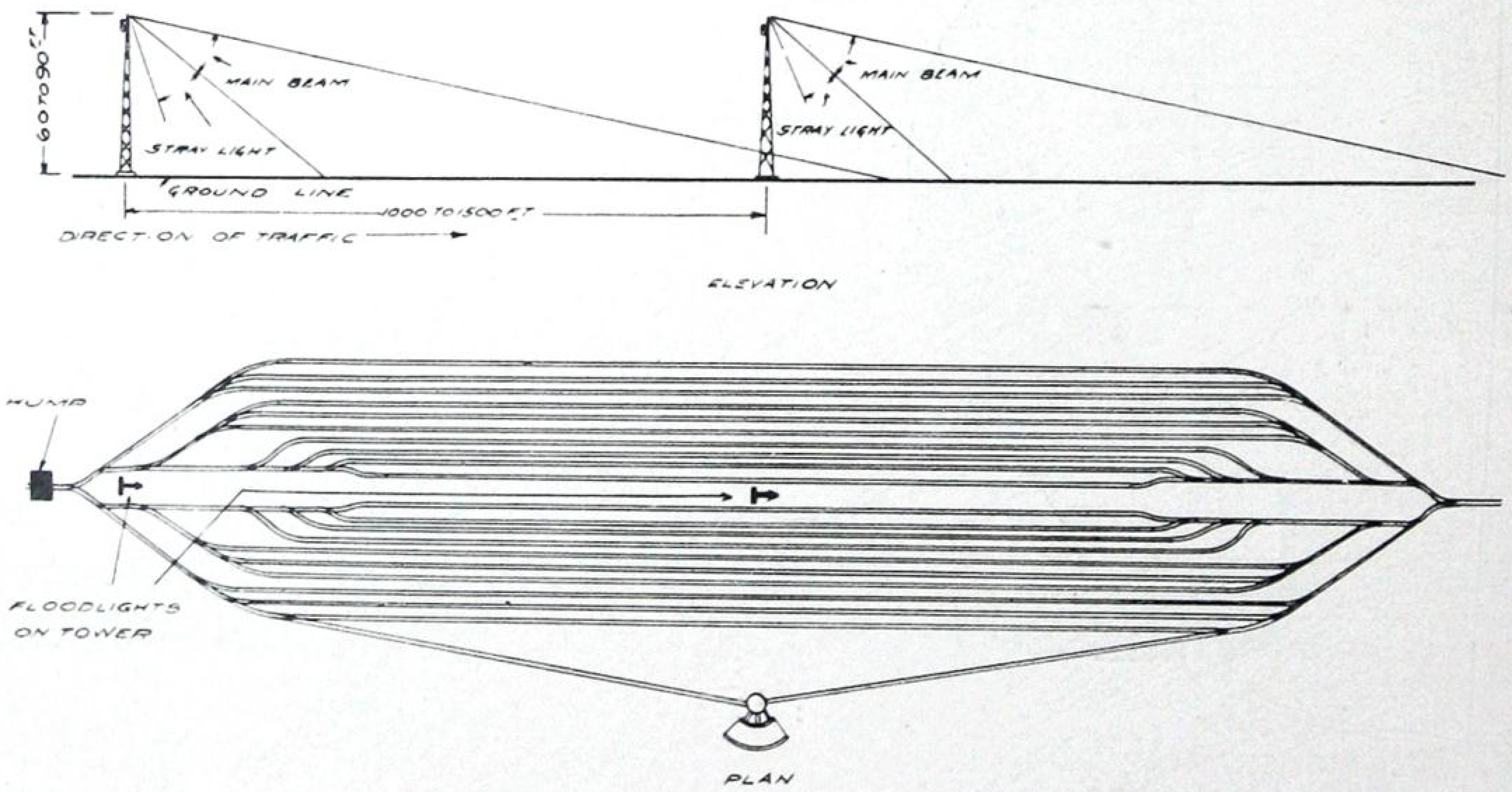


Fig. 9. An Alternative Arrangement to That Shown in Fig. 8

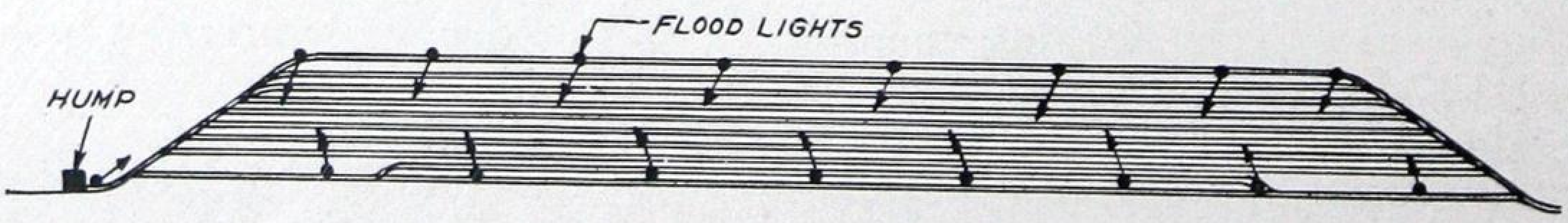


Fig. 10. Low Power Floodlighting with Close Spacing to Avoid Glare

Light Projected Against Direction of Traffic

Advantages:
- Uniform distribution of light
- Effective in smoke or fog
- Silhouette effect

Disadvantages:
- Higher installation and maintenance cost
- Possible glare.

Another variation of the distributed system is that in which the light is projected diagonally across the tracks against the direction of traffic. The projectors, singly, or in pairs, are as a rule mounted on 75-ft. poles or towers, spaced from 200 to 500 ft. apart. This system gives the silhouette effect and the effect of specular reflection from the rails, and also tends to provide uniform illumination throughout the yard.

Whatever system be used, the proper mounting height for the projectors is a most important matter. The greater mounting heights are preferable in order to minimize as much as possible the dangerous glare effects, to give a more uniform distribution of light, and to eliminate objectionable shadows. Towers 75 ft. high above the rails should be considered the minimum projector mounting height. Towers as high as 120 ft. are in use, and many of 90 ft. or more have been installed.

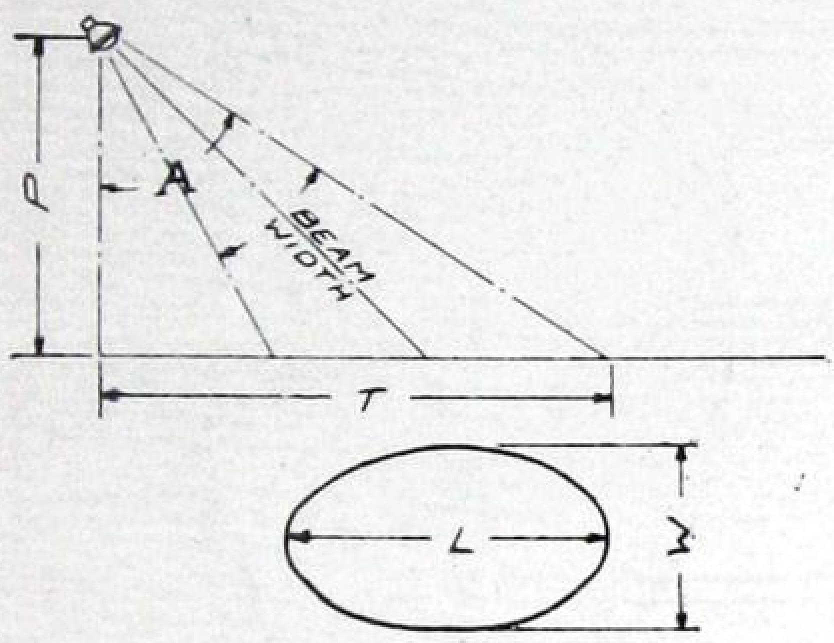
The projection efficiency of the unit is another important consideration. The suitability of the unit in this respect is measured

TABLE V

ILLUMINATING EFFICIENCY OF L-22 PROJECTOR

Approx. Watts. Per Sq. Ft.	Approx. Average Ft-cd.
0.0056	0.05
0.011	0 10
0 017	0.15
0 022	0 20
0.028	0 25

TABLE VI



FOOT-CANDLE INTENSITIES BASED ON ONE PROJECTOR ONLY USING A 1000 WAT
MAZDA C MULTIPLE LAMP
PROJECTOR WITH CLEAR DOOR GIVES 8825 BEAM LUMENS, 24° BEAM
PROJECTOR WITH STIPPLED DOOR GIVES 8950 BEAM LUMENS 32° BEAM
(FIGURES ARE CLOSE APPROXIMATIONS ONLY)

CLEAR GLASS DOOR

HEIGHT P	70 FT					80 FT					90 FT					100 FT					120 FT				
DISTANCE T	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC	ANGLE A	L IN FEET	W IN FEET	AREA	FC
200	70°43'	126'	61'	6040	1.46	68°12'	122'	64'	6190	1.43	65°46'	120'	68'	6350	1.39	63°26'	118'	71'	6550	1.35	59°2'	116'	77'	7000	1.26
400	80°5'	296	94'	21800	0.41	78°41'	287'	99'	22280	0.40	77°19'	279'	103'	22665	0.39	75°58'	272'	108'	23000	0.38	73°18'	261'	115	23580	0.38
600	83°21'	482'	120'	45320	0.20	82°25'	470'	126'	46650	0.19	81°28'	459'	133'	47760	0.19	80°32'	449'	138'	48670	0.18	78°41'	431'	148'	50125	0.18
800	85°	674'	142'	74925	0.12	84°17'	660'	150'	77620	0.11	83°35'	647'	157'	79900	0.11	82°53'	634'	164'	81825	0.11	81°28'	612'	177'	84910	0.10
1000	86°	868'	161'	109640	0.08	85°26'	853'	170'	114120	0.08	84°51'	839'	179'	117978	0.08	84°17'	825'	187'	121270	0.07	83°9'	799'	202'	126690	0.07
2000	88°	1857'	235'	342500	0.03	87°43'	1838'	250	360000	0.02	87°25'	1820'	264'	377500	0.02	87°8'	1803'	277'	391000	0.02	86°34'	1769'	304'	421000	0.02

LIGHT STIPPLED GLASS DOOR

100	55°	70'	53'	2935	3.05	51°20'	72'	57'	3250	2.76	48°1'	74	62	3605	2.48	45°0'	77	66	4000	2.24	39°18'	84	76	4970	1.80
200	70°43'	144'	76'	8575	1.04	68°12'	141'	81'	8960	1.00	65°46'	140	85	9300	0.96	63°26'	139	89	9750.	0.92	59°2'	139	98	10650	0.84
300	76°52'	230'	96'	17350	0.52	75°4'	225'	102'	17980	0.50	73°18'	221	107	18500	0.48	71°34'	217	112	19050	0.47	68°12'	212	121	20150	0.45
400	80°5'	322'	114'	28800	0.31	78°42'	315	120	29800	0.30	77°19'	309	126	30650	0.29	75°58'	304	132	31400	0.29	73°18'	295	142	33000	0.27
500	82°2'	417'	129'	42300	0.21	80°55'	408	137	43700	0.20	79°48'	401	144	45450	0.20	78°41'	393	150	46250	0.19	76°30'	382	162	48700	0.18
1000	86°	904'	191'	134850	0.07	85°26'	892	202	141800	0.06	84°51'	881	213	147650	0.06	84°17'	871	225	152800	0.06	83°9'	851	242	161700	0.06

by the total lumens delivered, by the beam lumens, and the beam candle-power. The total lumens are the measure of the total flux of light delivered by the projector; the beam lumens indicate the quantity of light flux in the beam; and the candle-power is the measure of the pressure or intensity of the light. The lighting of a railroad yard is the lighting of a large area, therefore consideration must be given to the coverage of the projector; i.e., to the spread of the beam. Obviously a narrow beam of high candle-power is not adapted to this class of service, for while it can be transmitted a great distance it results merely in a spot of light in the yard. It is, therefore, desirable to utilize a spread beam sufficiently great to obtain the coverage found necessary in practice and of sufficient candle-power to provide the desired illumination at distances from the projector corresponding to the usual spacings. In the design of the projector shown in Fig. 5 and 6 careful consideration has been given to the proper balance of lumens, candle-power, and spread of beam to obtain the maximum efficiency consistent with the other desirable characteristics. Towers and the space to install them in the railroad yard are expensive, and therefore every possible reduction should be made in these respects.

Table V represents modern practice which will meet existing conditions in average railroad yards, based upon the beam lumen output of the L-22 unit.

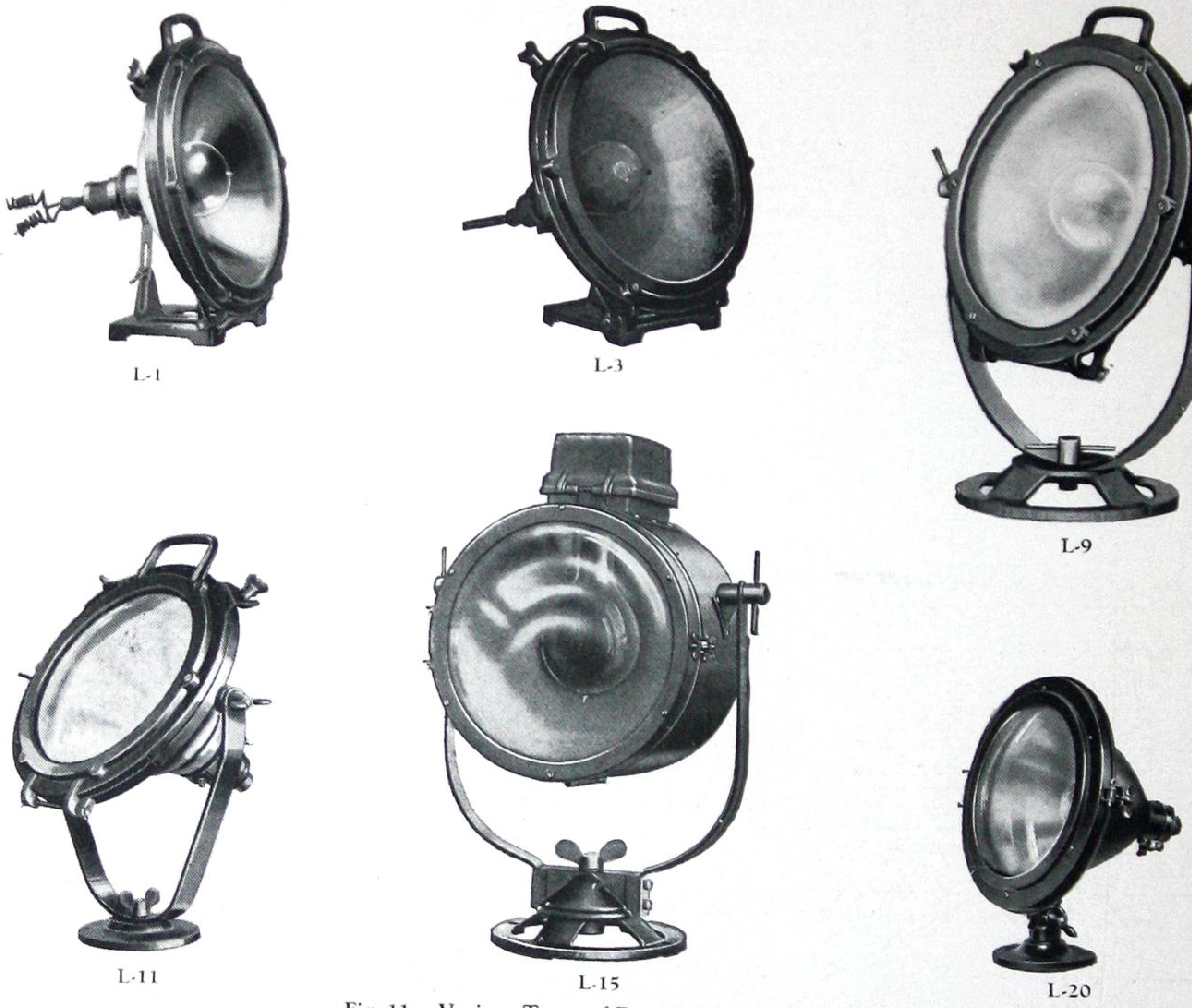
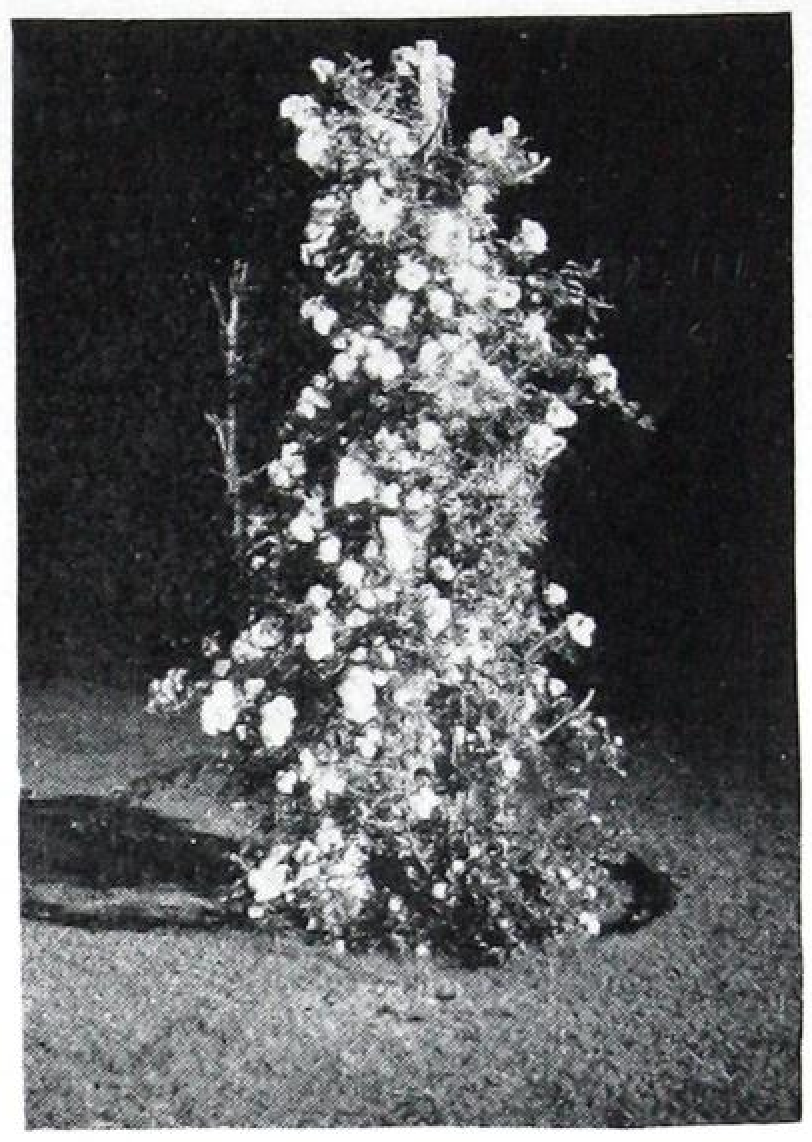


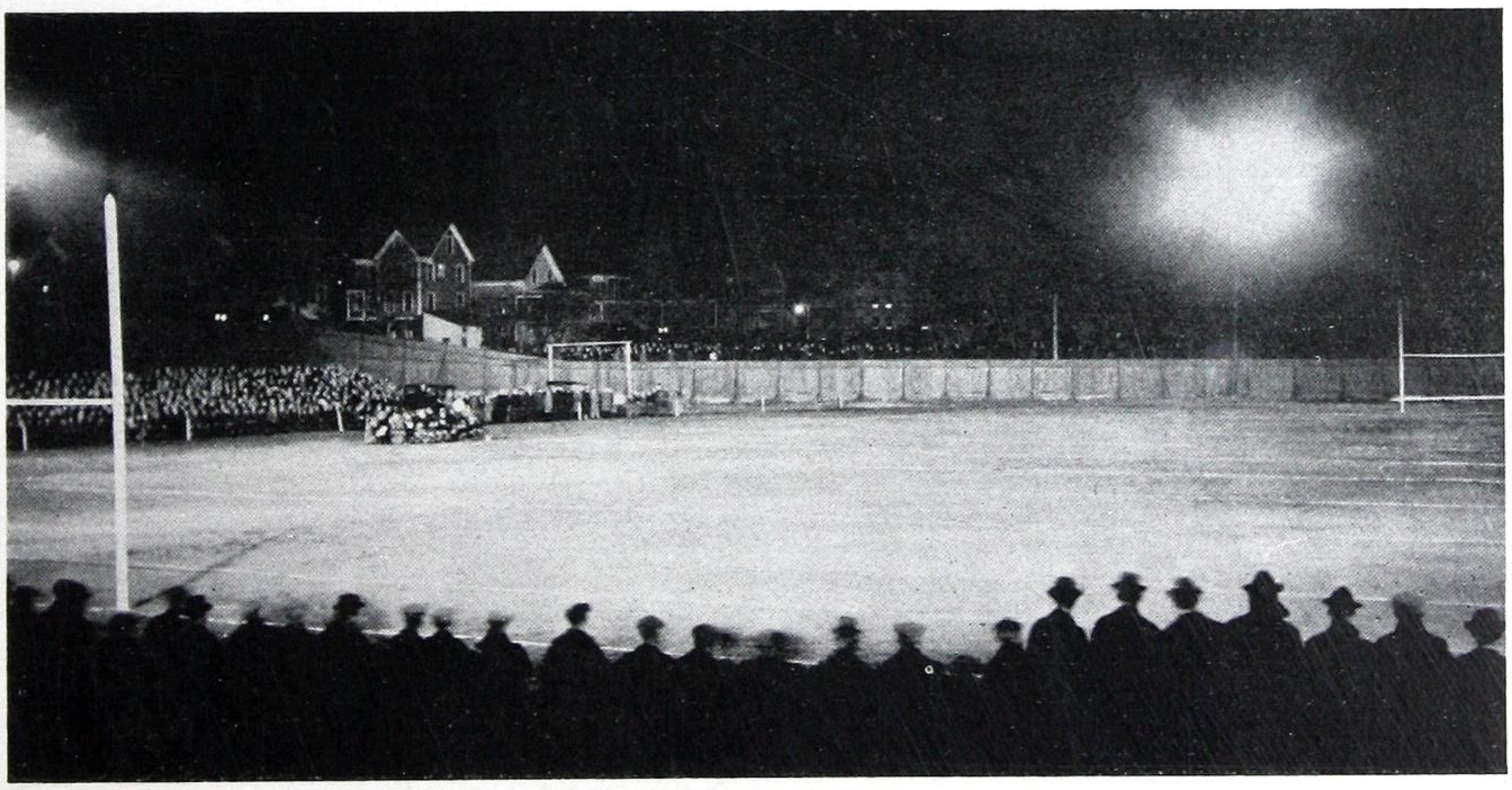
Fig. 11. Various Types of Floodlighting Projectors

Table VI also relates to the L-22 beam and gives the beam lengths, width, area, and beam foot-candles for both clear-glass and stippled-glass doors, together with the tilted angle necessary for the various mounting heights and spacings considered for this field of work.

In Fig. 11 are shown various types of floodlighting projectors that are in use today. By fitting each to the conditions for which it was designed, highly satisfactory lighting for all out-of-door purposes can be obtained.



One of the Newest Applications of Floodlighting is the Illumination of Foliage. This Installation is at "Forty Steps" Nahant, Mass.



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